"Geoenvironmental Engineering"

Schedule of Lecture

by Jiro Takemura

Topics:

- Introduction: *ground pollution, GTE vs EG, Mutli-disciplinary aspects*
- Hydrogeology: *Characteristics of ground water*
- Mechanisms of ground and ground water contamination:
  Physical law, *Derivation and solutions of advective- dispersive equation*
- NAPLs (Non-Aqueous Phase Liquids): *Basic properties of NAPLs*
- Remediation of contaminated site: *requirement, law and technology*
- Waste containment : *inland and offshore landfill*
- Radio active waste disposal:
- Problems caused by the GEJE and Tsunami

Grading system:

Assignment + GWs + Site visit: 60%, Final-exam: 40%,

Reference books used in the lecture:

- Daniel, D. E., (1993), "Geotechnical Practice for Waste Disposal", Chapman & Hall, London.
- Fetter, C. W.(1999) "Contaminant Hydrogeology 2nd ed", Waveland Press Inc, Long Grove, IL, USA.
- Bear, J. and Verruijt, A. (1990) "Modeling Groundwater Flow and Pollution", Reidel P.C., Dordrecht, The Netherlands.
- Bedient, P. B., Rifai, H. S. and Newell, C. H. (1994) " Ground water contamination- Transport and Remediation", PTR Prentice Hall, NJ, USA.
- Freeze, R. A. and Cherry J. A. (1979)" Groundwater", Prentice Hall, NJ, USA.
- Webpage of Ministry of environment: source of latest information http://www.env.go.jp/
- Webpage of USEPA: more info http://www.epa.gov/

Geoenvironmental Engineering - Introduction-

by the Cambridge Dictionary of English

Environment:

NATURE (the quality of) the air, water and land in or on which people, animals and plants live.

(narrow definition)

soil, ground water

+"pollution"

preserving ***improving***

SURROUNDING the conditions that you live or work in and the way that they influence how you feel or how effectively you can work.

(wide meaning or definition)

noise, vibration, smell

preventing, improving

Environmental problems in narrow definition

- Pollution of air and surface water
- **Pollution of soils and ground water**

  slow expansion of pollution due to low permeability ($K=10^{-5\sim-10}$ m/s)

  long term phenomena, accumulation

Use of ground water: How about Globe?

(Japan) 2007 12% of water demand

(28% of industry W, 22% of daily life W, 6% of agricultural W.)

http://www.mlit.go.jp/tochimizushigen/mizsei/chikasui/genjou.html

(US) 50% of drinking water (from public supply or private wells)

human health + conservation of ecosystem

Four aspects of ground pollution

1. Prevention of pollution
2. Evaluation of pollution
3. Remediation of contaminated ground
4. Conservation of environment

1.Prevention of pollution

• Regulatory requirement

the Basic Law for Environmental Pollution Control(1967)：公害対策基本法

Nation level:

(Japan): ***The Basic Environmental Law (1993)***：環境基本法

conservation of atmosphere
conservation of water environment
conservation of soil and ground water environment
policies of waste and recycling
policies on environmental risk of chemicals

Environmental Standard：環境基準
heavy metals, organic compounds, dioxin

State level: regulations, ordinance（条例）
more strict as additional requirement

2.Evaluation of pollutions

•type of pollutant
•**mechanism**
•**physical law**
•chemical law
•**site investigation**

3. Remediation of contaminated ground

•Methods
•Prediction
•Monitoring

•evaluation of contamination level
area, concentration
•target level **(standard)**
background value
(original level in nature)

huge demands or business for 20-30 years in developed countries
much longer in developing countries

In 1992, total expenditure on pollution control in US: $88B (1.5% of GDP(= $6,000B), $345/cap).

4.Conservation of environment

- **Education on Environment**
- **Engineering Ethics**
- **System of waste management**
- **Social System**: zero emission, *recycle, reuse, reduce*

Geoenvironment (EG) or Environmental Geotechnics covers wider area than Traditional Geotechnical Engineering (GTE) and needs many disciplines.

Ground pollution

Reported contaminated sites:

German:140,000

The Netherlands:110,000

US: 300,000-400,000

Japan: 232 (1994) =>

1,082（2001）as urban type pollution cases

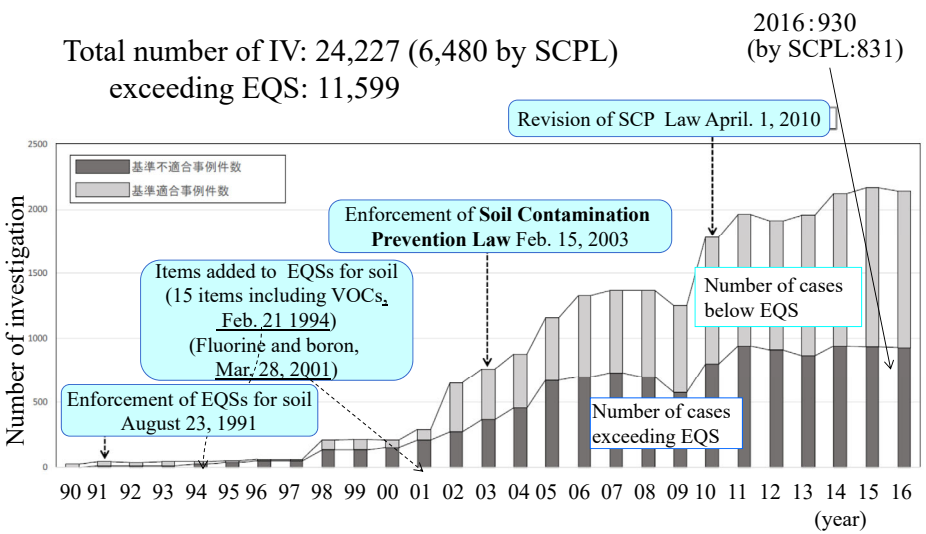
real number ??

960,000(as an estimation in 2000）

Number of soil contamination cases identified in Japan

Total number of IV: 24,227 (6,480 by SCPL)
exceeding EQS: 11,599

2016:930
(by SCPL:831)



http://www.env.go.jp/water/report/h30-01/full.pdf

Love Canal in Yew York State

- 1890: William Love:
  Land development => canal for hydraulic power plant
- 1893: Recession
- 1919: Abandoned and the canal left
- 1920～: Landfill
- 1942: Disposal of drums containing chemicals by Fucker Electric and Chemical Ltd., for 10 years
- 1953: Covered by clay material and sold to education council
  => school and residential
  the chemical slowly seeped out of the cover
- 1970s: rainfall, bad smell, health impact
- 1977 :investigation and all residence evacuated

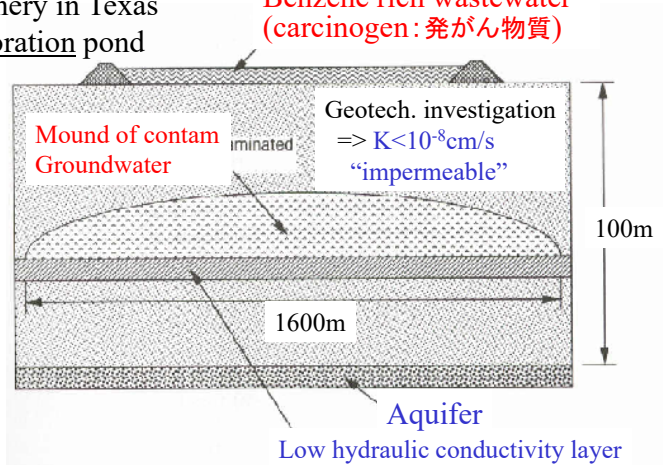
1980: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) = **"Superfund"**
cleanup the contaminated site, *Polluter Pays Principle, but provide monies if the responsible party cannot be identified or is incapable for cleanup*

Case histories

late 1950s, oil refinery in Texas with 600 ha evaporation pond

In 1980, regulatory agency directed the company to install ground water monitoring system.

Enormous pool of contaminated liquid was found.



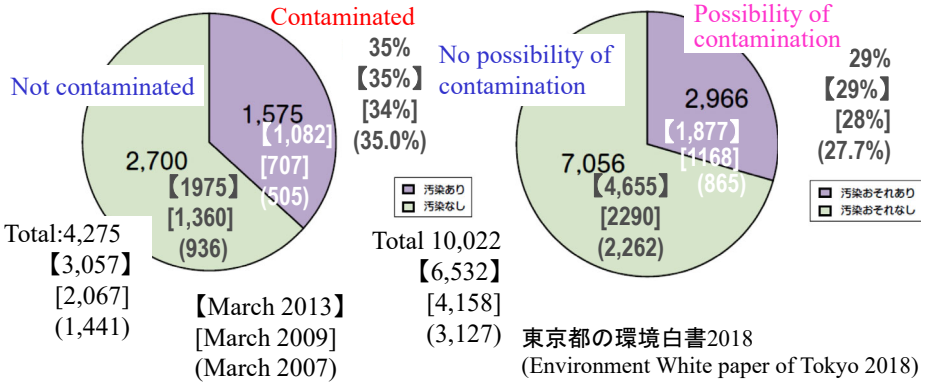
Pond operation was stopped and Remediation by 25 recovery well taking more than a decade.

Ground contamination of MGT

2001 the Tokyo Metropolitan Environmental Security Ordinance
東京都環境確保条例

Conditions of Contamination at the Time of Closing Factories (Article 116)
(Period: October 2001–March 2017)

Conditions of Contamination at the Time of Land Reform (Article 117) ≦ 3,000m²
(Period: October 2001–March 2017)



東京都の環境白書2018
(Environment White paper of Tokyo 2018)

Why geotechnical engineering can play important role?

Site investigations
- surface sampling
- soil vapor
- boring
- ground water

Remediation techniques
- degradation and changing non hazardous material
- separation and collection (pumping)
- solidification and stabilization (ground improvement)
- etc.

Multi disciplinary field

More than traditional geotechnical engineering

More than environmental geotechnical engineering

-Chemistry;
-Biology;
-Political science: *law, regulation;*
-Economics , e.g., environmental economics:
environmental business

Local, Regional <=> natural and social conditions

Ambient Level of Sulfur dioxide for six major cities

(annual average concentration, in μg/m^3)

	New York	Paris	Berlin	London	Tokyo	Montreal
1975	44	115	n/a	119	60	41
1980	38	89	90	69	48	41
1981	40	71	77	72	n/a	n/a
1982	39	68	82	57	42	n/a
1983	36	61	67	49	29	n/a
1984	38	57	n/a	46	27	n/a
1985	n/a	54	n/a	41	n/a	n/a
1995	26	14	18	25	18	10

Sources: U.S. Environmental Protection Agency, *International Comparison of Air Pollution Control*, Washington, DC, 1988, pp. 11–12, as presented in Raymond J. Kopp, Paul R. Portney, and Diane E. DeWitt, *International Comparisons of Environmental Regulation*, Resources for the Future, Washington, DC, 1990, p. 11; World Bank, www.worldbank.org/data/ databytopic/databytopic.html, at air pollution.

(Environmental Economics: B.C. Field &M.K. Field)

Environmental indicators for selected OECD countries in recent years 1999data

(Environmental Economics: B.C. Field &M.K. Field)

	Australia	Canada	France	Hungary	Italy	Japan
Emissions:						
SO_2 (kg/capita)	100.7	88.9	16.2	64.5	23.1	7.3
NO (kg/capita)	118.5	67.1	29.1	19.4	30.9	11.3
CO_2 (tons/capita)	16.6	15.8	6.2	5.7	7.4	9.3
Wastewater treatment (percent of population served) 下水道普及率	n/a	78	77	22	61	55 (2011 70.6)
Municipal solid waste generated (kg/capita) 廃棄物生産量	690	490	590	500	460	400
Nuclear waste* 核廃棄物	negligible	5.6	4.6	2.2	negligible	1.9
Noise**	n/a	n/a	9.4	n/a	n/a	38.0

* waste from spent fuel arising in nuclear power plants, in tons of heavy metal per million tons of oil equivalent of total energy supply.

Environmental indicators for selected OECD countries in recent years (cont.)

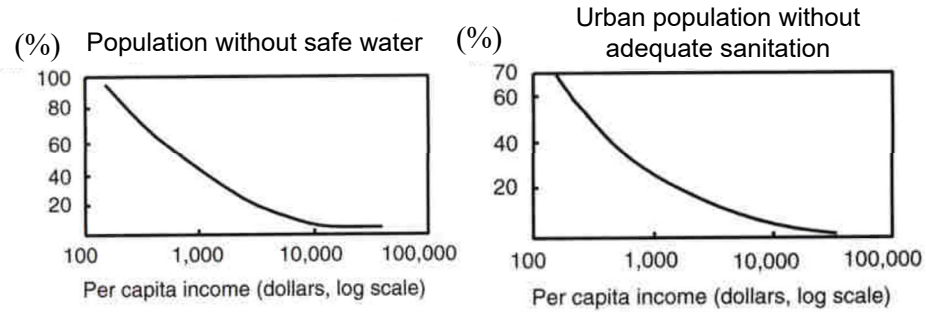
(Environmental Economics: B.C. Field &M.K. Field)

	Korea	Mexico	Sweden	United Kingdom	United States
Emissions:					
SO_2 (kg/capita)	32.9	23.2	10.3	34.5	69.0
NO (kg/capita)	27.6	16.4	38.1	35.0	79.9
CO_2 (tons/capita)	9.2	3.5	6.0	9.4	20.4
Wastewater treatment (percent of population served)	53	22	93	88	71
Municipal solid waste generated (kg/capita)	400	300	360	480	720
Nuclear waste*	2.1	0.3	4.6	3.6	1.0
Noise**	n/a	n/a	0.3	5.7	17.2

**: million inhabitants exposed to Leq> 65dB
Source: OECD, Environmental data, 1999

Environmental indicators in relation to country income level

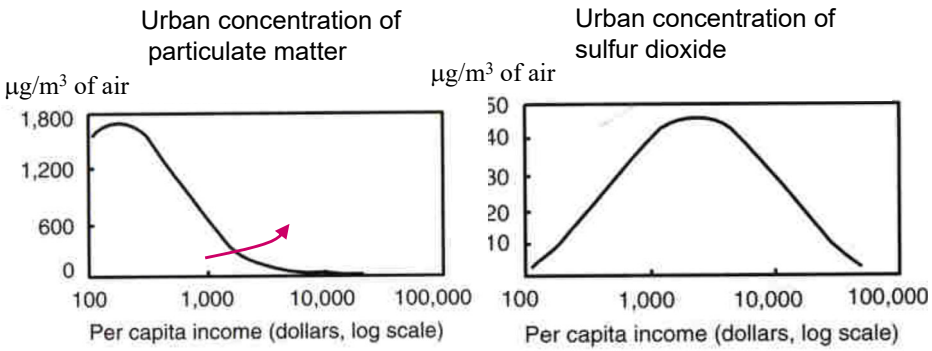
(Environmental Economics: B.C. Field &M.K. Field)



improvement of environmental conditions with IC *technology, education*

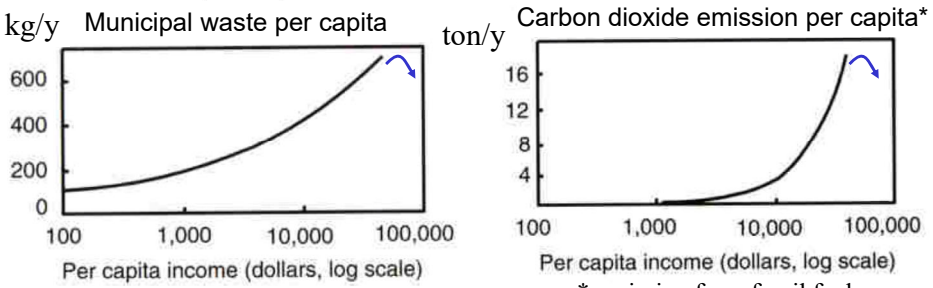
Environmental indicators in relation to country income level (cont.)

(Environmental Economics: B.C. Field &M.K. Field)



environmental conditions in the process of nation development
first *industrialization, urbanization*,
later *technology* + ***regulation***

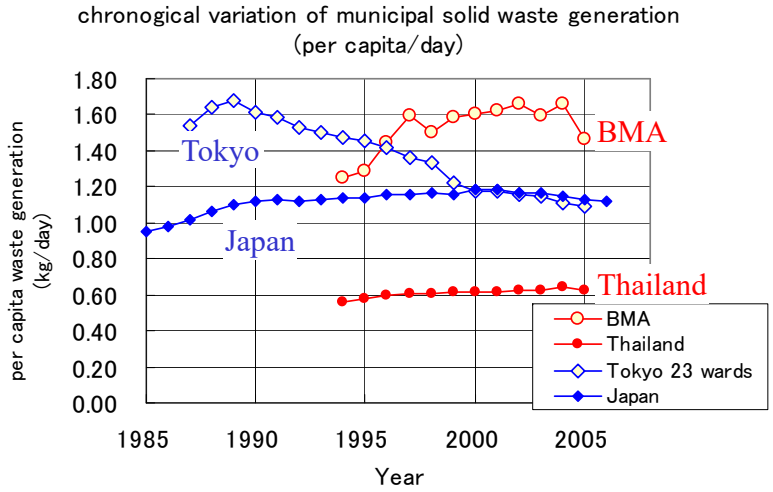
Environmental indicators in relation to country income level (cont.) (Environmental Economics: B.C. Field &M.K. Field)



*:emission from fossil fuels

Steady increase with IC,
showing material demand and energy demand both increasing with development level of nation.
This needs more technology, education and social system!!
=> *Serious demands promote technology and education.*

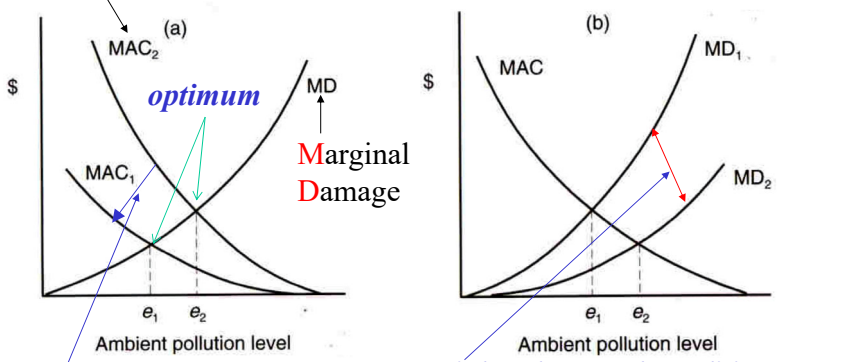
Municipal solid waste Generation in Japan, Thailand, Tokyo, Bangkok



Data: MOE, MPGT, Bureau of Environment, TMG, 2006

Optimum level of environmental quality using marginal cost - damage (benefit)

Marginal Abatement Cost: cost reducing the pollution level



technology

social and natural conditions*, *method or accuracy of evaluation

Group Work

(Four or five students each group)

1st objective: Problem statement or finding in environmental issues in your own county and similar one in Japan;

Similarity and Difference

Last Year Common problems: Toyosu new market

2nd objective: Summary of Key issues to solve the problems

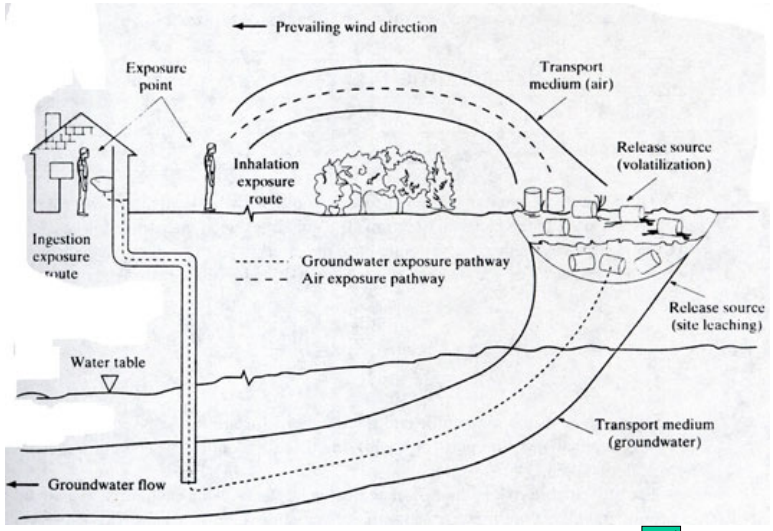
specific conditions in the country/ the experiences in other country including Japan/ technological action/ legal action

?

Presentations by PPT in the beginning of Lecture (15mins).

Submitted material: PPT files for presentation and written report for each objective

Example of exposure pathway



Home page address
on
the course material
Geo-environmental Engineering

http://www.geotech.cv.titech.ac.jp/~jtakemur/

Click:class

Click : Geoenvironmental Engineering (2019, Spring Semester)

In order to access course materials (PDF file)
HW Answer examples & Final Exam problem sets

+

OCWi
Class handout